Essential Readings in Light Metals: Alumina and Bauxite.
Edited by Don Donaldson and Benny E. Raahauge.

9. HEALTH, SAFETY, AND PLANT MAINTENANCE

This is a broad and important subject but it does not receive corresponding attention in the TMS alumina and bauxite annual symposium. Only six papers were selected for this book; half were about high pressure safety, design, and maintenance in digestion. It is only within the last several years that papers concerning other plant maintenance have been presented.

A significant cost in production of alumina is maintenance of refinery facilities. Many maintenance issues have a technical aspect, such as wear of equipment, methods of cleaning of scale, efficiency of pumps and agitators, and reliability of equipment.

Submission of more papers on the technical aspects of refinery maintenance is encouraged.

Don Donaldson

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APPLICATION OF OPERATION INTEGRITY MANAGEMENT IN THE ALUMINA INDUSTRY

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Abstract

In today's economic environment the Safety of our industry assets – People, Equipment and Processes – have become even more demanding. This paper provides means to apply Operation Integrity Management System (OIMS) to the Alumina Industry. It discusses what OIM is about, its implementation parameters such as cost and time, as well as an effective way to integrate such a system into refineries day to day operations. A series of Key Process Performance Indicators (KPPIs) are presented as well as an Electronic Knowledge Support System (EKSS) Mockingbird ® as a tool to support the implementation of OIMS.

Introduction

Alumina refinery operators can use Operations Integrity Management Systems (OIMS) to improve their Process Safety and Operations Performance.

Throughout this paper the authors will refer to Process Safety Management (PSM) as an equivalent system adopted by the Highly Hazardous Materials chemicals and petrochemicals operations.

Alumina refinery safety in the USA is mainly regulated by the Mining Safety Health Administration (MSHA). This branch of the Department of Labor focuses on employee's health and safety aspects related to surface and underground mining operations. The Occupational Safety and Health Administration (OSHA); another branch of the Department of Labor, regulates chemical and petrochemicals operations. It is important to mention this difference since OSHA regulates process safety activities and systems through PSM while MSHA does not. It is up to alumina refineries management to adopt PSM or OIMS elements to cover the safety of their process, their employees and their surrounding communities.

As the different elements of OIM are presented you will realize that a lot of them already form part of your refinery ISO, Health, Safety and Environmental systems. This makes it easier for the integration, implementation, cost and time reduction to deploy such a system.

The success in implementing OIMS depends among other things on how quick the refinery culture embraces and supports it.

Once the elements are in place, the deployment, auditing and further improvements can be enhanced by using an Electronic Knowledge Support System. Mockingbird ® and its suite of applications have been successfully used by the chemical and petrochemical industry over the years. This paper discusses the strategy and implementation of such a system in an alumina refinery environment.

What is OIM

Operational Integrity Management (OIM) consists of an integrated set of theories, practices and techniques for ensuring that an industrial facility operates "with integrity", *i.e.,* that the facility's performance is what it should be - no more, no less.

A Brief History of Integrity Management

The path of integrity management systems began in the United States, where in 1992 the Occupational Safety and Health Administration (OSHA) introduced its Process Safety Management Program. The goal of its 14 strands was to prevent or minimize the consequences of catastrophic accidents caused through the release of chemicals. The program requires a holistic approach that integrates technologies, procedures and practices, creating multiple barriers of protection.

For the oil and gas sector, the impetus behind the development of integrity management systems came from the Piper Alpha disaster in 1988, in which 167 people lost their lives. The inquiry into the disaster produced the Cullen Report, where the primary recommendation was that operating companies should be required to implement safety management systems that ensure safe design and operation of offshore installations.

The report specified that such system should draw on quality assurance principles similar to ISO 9000. The Cullen Report's recommendations were accepted immediately by the British government and the new regime that resulted has influenced the development of integrity management systems around the world.

The following have been reported as precursors to the Piper Alpha incident:

- **Corporate Pride and Craftsmanship**
- **Complaisency rather than Competency**
- **Change to the Rules**

The initial response by the industry included the following:

- **Mitigation of smoke hazards**
- **Installation of sub-sea pipeline isolation systems**
- **Improvements to the "Work Permits" management system**
- **Relocation of some pipelines emergency shutdown valves**

The Elements of OIM

Below is a brief description of the OIM elements shown in figure 1.

1. **Management** establishes policy, provides perspective, sets expectations and provides the resources for successful operations. Assurance of Operations Integrity requires management leadership and commitment visible to the organization, and accountability at all levels. The adoption of such system is driven by the General Manager and his/her team of Functional Managers.

2. Comprehensive **risk assessments** can reduce safety, health, environmental and security risks and mitigate the consequences of incidents by providing essential information for decision-making. Mitigating risks at the early stages of design and the continuation in the operation phase is a must.

3. Inherent safety and security can be enhanced, and risk to health and the environment minimized, by using sound standards, procedures and management systems for **facility design, construction** and startup activities.

4. **Accurate information** on the configuration and capabilities of processes and facilities, properties of products and materials handled, potential Operations Integrity hazards, and regulatory requirements is essential to assess and manage risk. Process Safety Information such as P&IDs, Materials Safety Data Sheets should reflect current operation.

5. Control of operations depends upon people. Achieving Operations Integrity requires the appropriate screening, careful selection and placement, ongoing assessment and **training of employees**, and the implementation of appropriate Operations Integrity programs. Apply Management of Change when dealing with new personnel assignments, particularly in the plant areas.

6. Operation of facilities within established parameters and according to regulations is essential. Doing so requires effective procedures, structured inspection and maintenance programs, reliable **Operations Integrity** critical equipment, and qualified personnel who consistently execute these procedures and practices. Make sure that Standard Operating Procedures for both Process Operations and Maintenance reflect current systems.

7. **Changes** in operations, procedures, site standards, facilities, or organizations ***must be evaluated and managed*** to ensure that Operations Integrity risks arising from these changes remain at an acceptable level.

8. **Third parties** carrying out work on the company's behalf impact its operations and its reputation. It is essential that they perform in a manner that is consistent and compatible with Company's policies and business objectives. Evaluate and train contractors before starting any work.

9. **Effective incident investigation**, reporting and follow-up is necessary to achieve ***Operations Integrity***. They provide the opportunity to learn from reported incidents and to use the information to take corrective action and prevent recurrence. Monitor and request reports from any incident, no matter how small or insignificant to the perception of the affected.

10. Effective management of stakeholder relationships is important to enhance the trust and confidence of the communities where the business operate. **Emergency planning and preparedness** are essential to ensure that, in the event of an incident, all necessary actions are taken for the protection of the public, the environment and company personnel and assets. Make it a point to run simulations and drills periodically so that everybody involved react according to plan.

11. **Assessment** of the degree to which expectations are met is essential to improve Operations Integrity and maintain accountability. Involve all levels of the organization in routine audits. Make it a point to discuss results and focus on corrective actions.

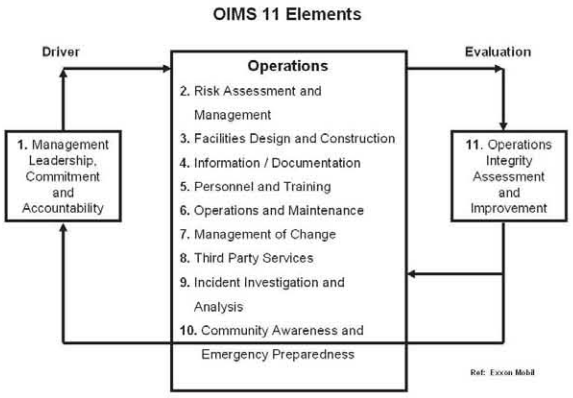


Fig 1. OIM 11 Elements

Refinery Culture and How to Promote OIM

Cultural Attributes

1. ***Culture is a feature of the entire organization***, not just of some of the individuals within that organization. Therefore, if someone — even the general manager — leaves the organization, the culture of that organization should not change significantly.

2. ***Culture is on-going — it is not a one-time event***. A facility in which everyone is continuously striving to identify and correct problems and to eliminate hazardous conditions has a strong operational integrity culture, whereas a facility which makes only

spasmodic and irregular efforts to improve such conditions does not.

3. In a strong OIM culture there is ***minimal disconnect between words and actions***. All managers and workers 'walk the talk'; their words and deeds match.

4. The creation and maintenance of an organizational culture requires ***leadership from the top***. Allowing lower level employees to "do their own thing" does not create a culture.

5. It is difficult for any organization to truly assess the quality of its own culture. It takes an outsider to truly evaluate the quality of a company's culture. Therefore, an organization with a strong OIM culture will make ***frequent use of outside auditors, inspectors and reviewers*** to identify areas of weakness and to suggest corrective actions. Moreover, the auditors' reports will go directly to the facility managers

6. A strong OIM culture is one in which employees and contract workers ***feel free to report on difficulties and problems***, even if those employees and workers are potentially opening themselves up to criticism

7. With regard to SHE (Safety, Health and Environmental) issues, the organization places ***excessive emphasis on the safety term***, to the detriment of the health and environmental elements.

8. A strong operational integrity management culture ***adapts to new circumstances*** without its basic values being affected by issues such as economic downturns or the adoption of new technologies. It is suggested here that management can go about creating a strong operational integrity culture by following the three steps shown below:

1. Prepare and publish a ***Mission Statement*** that spells out the organization's stated commitment to operational integrity management principles.

2. Develop guiding tenets that show how the OIM program is to be implemented.

3. Develop a detailed program showing how the guiding tenets are to be achieved.

OIM provides unparalleled capacity for enhanced risk reduction. A company's risk exposure is reduced in the following areas when well-founded process safety systems are in place.

Lives are saved and injuries are reduced — Both the personal impact of human loss and cost of deaths or injuries are painful. A solid OIM program can help prevent these costs

Property damage costs are reduced — In the U.S., major industrial incidents cost an average of $80 million each

Business interruptions are reduced — These losses can amount to four times the cost of the property damage from an incident

Loss of market share is reduced — After an incident, this loss continues until the company's reputation is restored. Adverse publicity and negative public image can have insurmountable effects

Litigation costs are reduced — These are unavoidable after an incident and can total five times the cost of the regulatory fines.

Incident investigation costs are reduced — Investigating an incident and implementing corrective actions can cost millions of dollars

Regulatory penalties are reduced — For many incidents, a fine after litigation can total 1 million dollars or more

Regulatory attention is reduced — A major incident usually results in increased regulatory audits and inspections

Key Performance Indicators

Examples of KPIs for Operation Integrity Management are shown in figure 2 below.

Management Leadership, Commitment and Accountability
Leadership Participation in Incidents Investigation
Participation in OIM Program Assessment
OIM Contribution as Part of the Employees Performance Assessment
Risk Assesment and Management
% of Risk Assessment Corrective Actions Completed to Schedule
% of Risk Assessments Reviewed to Schedule
Facilities Design and Construction
% P&IDs Conformance to Current Process Installations
As Built Drawings Available and in Conformance
Facilty Design and Built per Sound Standards
Information / Documentation
% of Critical Operational and Maintenance Procedures Reviews Completed to Schedule
% Compliance with Critical Procedures
Material Safety Data Sheets (MSDS) Availability to all Operating Areas
Personnel and Training
Mandatory Training Completed to Schedule
Personnel Trained on New Standard Operating Procedures
Operations and Maintenance
All Critical Controls for Process Safety Identified
% of Controls Inspected to Schedule
% of Controls Outside Tolerance
% Compliance with Critical Procedures
Management of Change
% of MOC Documents Compliant with Procedures
% of Temporary Changes Overdue
% of MOC Physically Installed but Awaiting Completion of Documentation
Third Party Services
Assessment of Capabilities to Performed Work
Deficiencies Corrected
Effective Communication
Incident Investigation and Analysis
% of Overdue Incident Investigations
No of Repeat Incidents Occuring
% of Follow Up Corrective Actions Completed to Schedule
Lessons Learned from Company and Industry Incidents
Community Awareness and Emergency Preparedness
No of Emergency Exercises / Desktop Exercises Completed to Schedule
Emergency Plan Reviewed to Schedule
Operations Integrity Assessment and Improvement
% of Inspections or Tests Completed to Schedule
% Compliance with Standards and Procedures

Figure 2 – KPIs for OIM Elements

OIM Implementation Parameters

To succeed in business a company must:

- Protect its license to operate
- Meet ever more demanding regulatory requirements
- Manage the sustainability of your business

- Raise stakeholder and public confidence
- Minimize and, where practicably possible, eliminate the risk of incidents

How to Implement an OIM System

- Assign an OIM Manager (or team)
- Learn from the literature (check key references)
- Learn by training (from process safety professionals)
- Learn from other companies – align; network; participate in industry alliances
- Note strong synergies with ISO, TQM, RMP, Responsible Care
- Set some clear OIM goals (one to five years)
- Track performance versus the goals on a regular basis
- Reassess OIM/plan & modify (every 3-5 yrs)

The best OIM companies show the following attributes:

- OIM Champions who affiliate themselves with multiple disciplines (e.g., EHS, Engineering, Operations, Insurance) to work collaboratively

- Functionally having two platforms to identify, analyze, select, implement, control & monitor process; i.e., worst case (top down) and more frequent events (bottom up)

- Regularly conduct reviews of the OIM program against the defined elements, and

- Especially promote risk engineering in the conceptual engineering design phase.

Time

Research has shown that the following level of compliance can be attained after the implementation of an OIM system:

- 40% level of compliance First Year (Baseline)
- 50% level of compliance Second Year
- 100% level of compliance anticipated in Fifth Year
- Excellence in OIM program anticipated Seventh Year

Time is dependent on how many documented similar elements the business already have in place in the organization that can be brought into OIM or easily adapted.

Cost

The labor cost for developing and implementing an OIM element can be accounted for in one or more of the following categories:

- Meetings
- Writing
- Reviewing
- Revising
- Training/Orientation
- Pilot testing
- More revising
- Initial implementation

The cost areas for years 1-5 includes (1) the remaining cost to reach 100 % compliance and (2) the ongoing cost to maintain compliance (or quality) for the remaining years if the company reaches 100 percent compliance in that period.

The cost for developing the program is described below:

Developing an OIM Program. The cost, primarily in equivalent labor costs, to bring the OIM program (and individual element programs) from the concept stage through the final design (such as developing an MOC or MI written program that the facility personnel are confident will work). This category also includes the cost of training personnel to be proficient in various OIM activities, such as leading PHAs, leading incident investigations, leading compliance audits, writing procedures, and leading employee training.

Implementing an OIM Program. The cost (again primarily in equivalent labor costs) to do implementation tasks, such as writing operating procedures, updating PSI, doing initial training of operators and maintenance personnel, and performing/documenting Process Hazard Analysis - PHAs.

Responding to Recommendations. The cost, primarily capital costs and expenses, to implement improvements to address recommendations from PHAs, MOC hazard reviews and incident investigations.

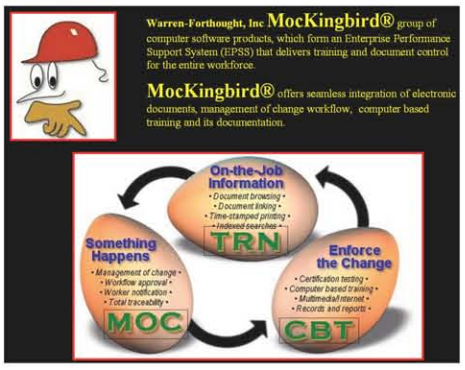
As a rule of thumb $22,000 - $25,000 per P&ID might be used as the cost associated for the development and implementation of an OIM system.

Mockingbird ® (EKSS)

Mockingbird ® is an Electronic Knowledge Performance System widely used by the Chemical and Petrochemical industry to support OIM / PSM systems development, implementation and manage compliance.

The initial population of the system takes place during the "Miracle Month". This period is used for training on the system, designing its structure and have all involved take ownership.

Mockingbird ® becomes the portal for all OIM elements and its tools.



Conclusions

- OIM can be easily implemented in any alumina refinery for which other systems such as ISO, Safety, Health and Environmental already exists.
- OIM can be a combination of the elements listed in this paper and those defined for PSM
- The successful implementation and continuity in the use of OIM depends on the organization commitment to support it
- It is important that a strong safety culture be promoted and nurtured
- The existence of other systems such as ISO, Safety, Health and Environmental, etc will make the OIM system implementation less costly and shorter in time
- Refineries that reach an excellence level of compliance with OIM will also show an overall improvement in financial and operating levels
- Mockingbird ® and its application suites offer a sound and robust platform on which to manage OIM

Further Readings

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